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Lignite Fuel Enhancement
EPRI ELECTRIC POWER RESEARCH INSTITUTE
U.S. DEPARTMENT OF ENERGY

Coal Creek Prototype Fluidized Bed Coal Dryer:

Performance Improvement, Emissions Reduction, and Operating Experience

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EPRI Program 66 CoalFleet for Tomorrow:
San Francisco, CA February 27, 2007

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Introduction

- *Coal moisture has a large negative effect on boiler efficiency, station service power and unit heat rate.*
- *For a 600 MW lignite-fired unit, fuel moisture is responsible for:*
  - *9% higher coal flow rate*
  - *20 MW of station service power*
  - *20% higher flue gas flow rate*
  - *Increased operating and maintenance cost*
- *Can a low-temperature waste heat be used to reduce fuel moisture?*

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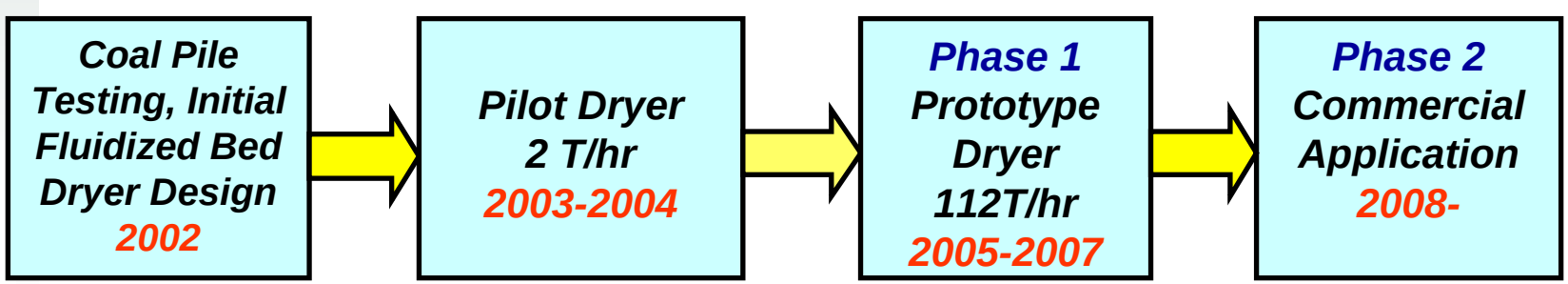
Project Goals and Schedule

- **Goals and Objectives:**
  - *Reduce moisture content of lignite, PRB, and other high-moisture fuels.*
  - *Use waste heat from the power plant.*
  - *Modify existing coal handling systems.*
  - *Increase competitive position of lignite-, PRB-, and other high moisture coal-fired power plants.*
  - *Reduce environmental impact of lignite-, PRB-, and other high-moisture coal-fired power plants*
- **Project Phases and Schedule:**



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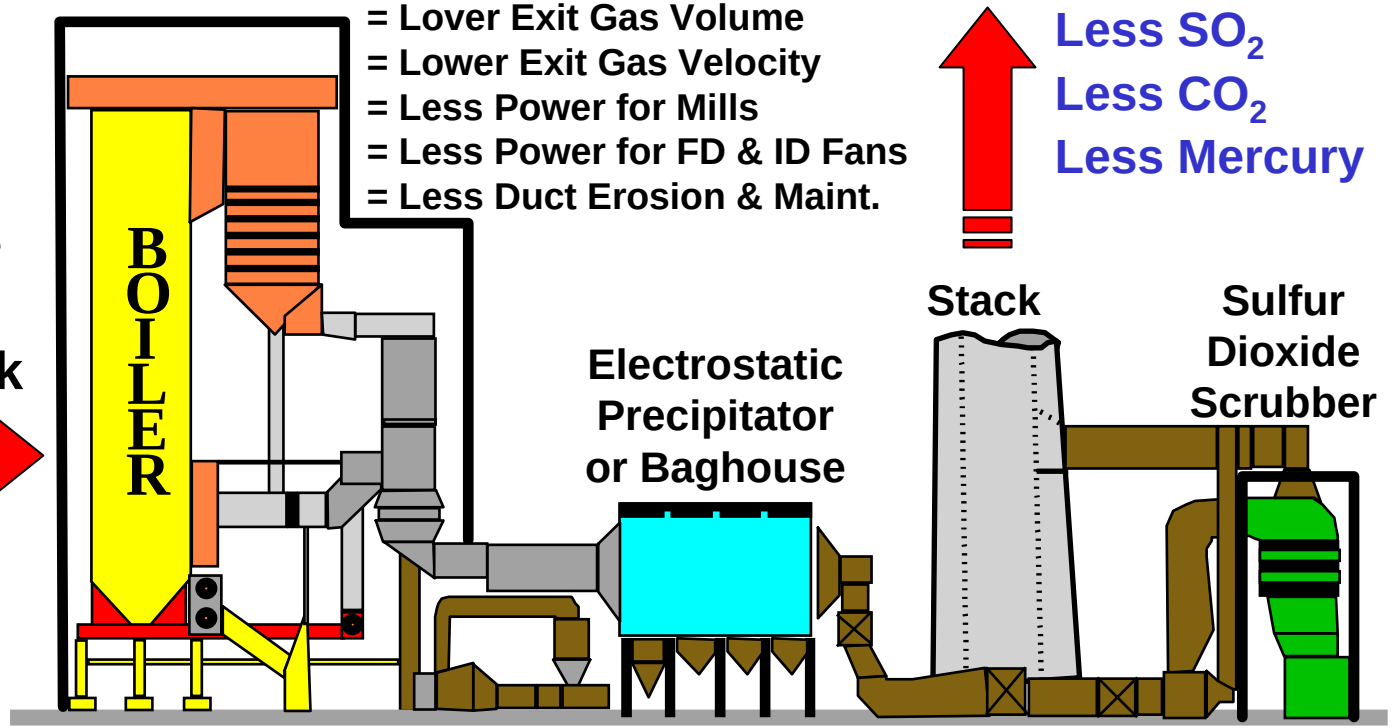
Lignite Fuel Enhancement: Incremental Moisture Reduction Project

Less Moisture:
= Lower Exit Gas Temperature
= Lover Exit Gas Volume
= Lower Exit Gas Velocity
= Less Power for Mills
= Less Power for FD & ID Fans
= Less Duct Erosion & Maint.

Less Ash
Less SO_2
Less CO_2
Less Mercury

Lower Moisture Lignite Feedstock



Increased Efficiency
More MW/Ton

Increased Efficiency
Less Flue Gas
Lower Velocity

Increased Efficiency
Less Flue Gas
Lower Velocity
Less Evaporation

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Previous Work

- **1997-1998**
  - *Preliminary studies and concept development*
- **1999**
  - *Lignite-drying tests at Coal Creek using low-temperature fixed-bed dryer.*
- **2000**
  - *Coal Creek boiler modeling*
  - *Laboratory lignite drying tests.*
  - *Full-scale test burns (20,000 tons of lignite dried using low-temperature air, and burned at Coal Creek).*
- **2001**
  - *Fluidized bed selected for coal drying*
  - *Laboratory drying tests at Lehigh University*
- **2002**
  - *Application filed with DOE under the Clean Coal Power Initiative (CCPI).*

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Previous Work

- **2003**
  - *Project selected for negotiation with DOE.*
  - *2 ton/hr pilot fluidized bed dryer built at Coal Creek with NDIC funding.*
  - *Pilot coal dryer testing at Coal Creek*
- **2004**
  - *Contract signed with DOE (Clean Coal Power Initiative).*
  - *DOE joined partnership under collaborative agreement.*
  - *Design of a prototype coal dryer and associate equipment.*
- **2005**
  - *Construction begins of a prototype coal dryer at Coal Creek Unit 2.*
- **2006**
  - *Prototype coal dryer checkout and start-up*
  - *Prototype coal dryer performance testing (in progress)*
  - *Unit performance testing (in progress)*
  - *August:* ***Phase 1 Milestone***

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Prototype Coal Drying System at Coal Creek

Prototype Coal Dryer

- Maximum capacity **112.5 t/hr**.
- Remove approx. ¼ of coal moisture.
  - Dry lignite from **38.5%** to **29.5%**.
  - Improve HHV from **6,200** to **7,045** BTU/lb
- Fully automated operation, integrated into the plant control system.
- Four patent applications on dryer design and control filed by GRE.

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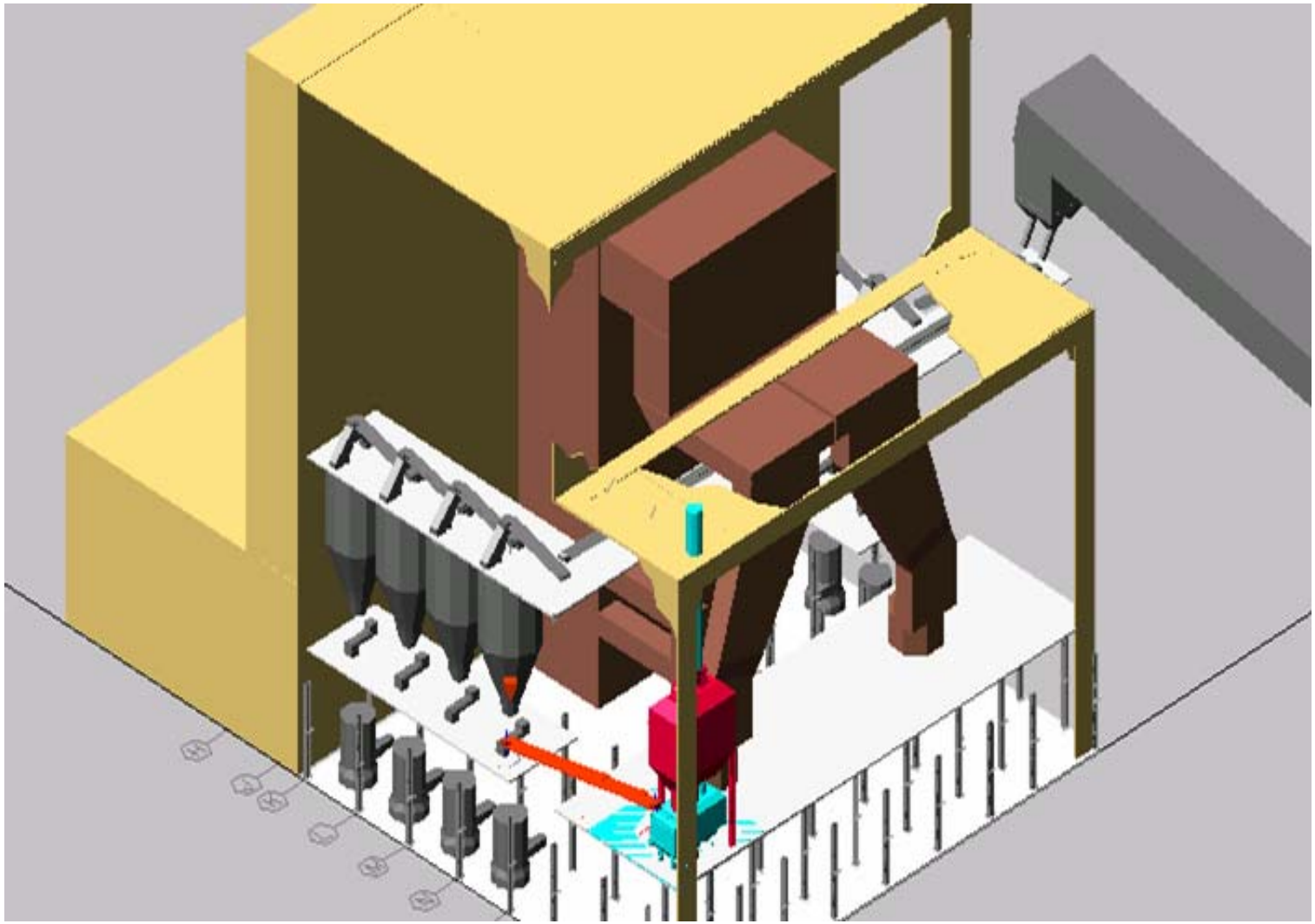
Prototype Dryer: Unit 2 East



Prototype Dryer Installation

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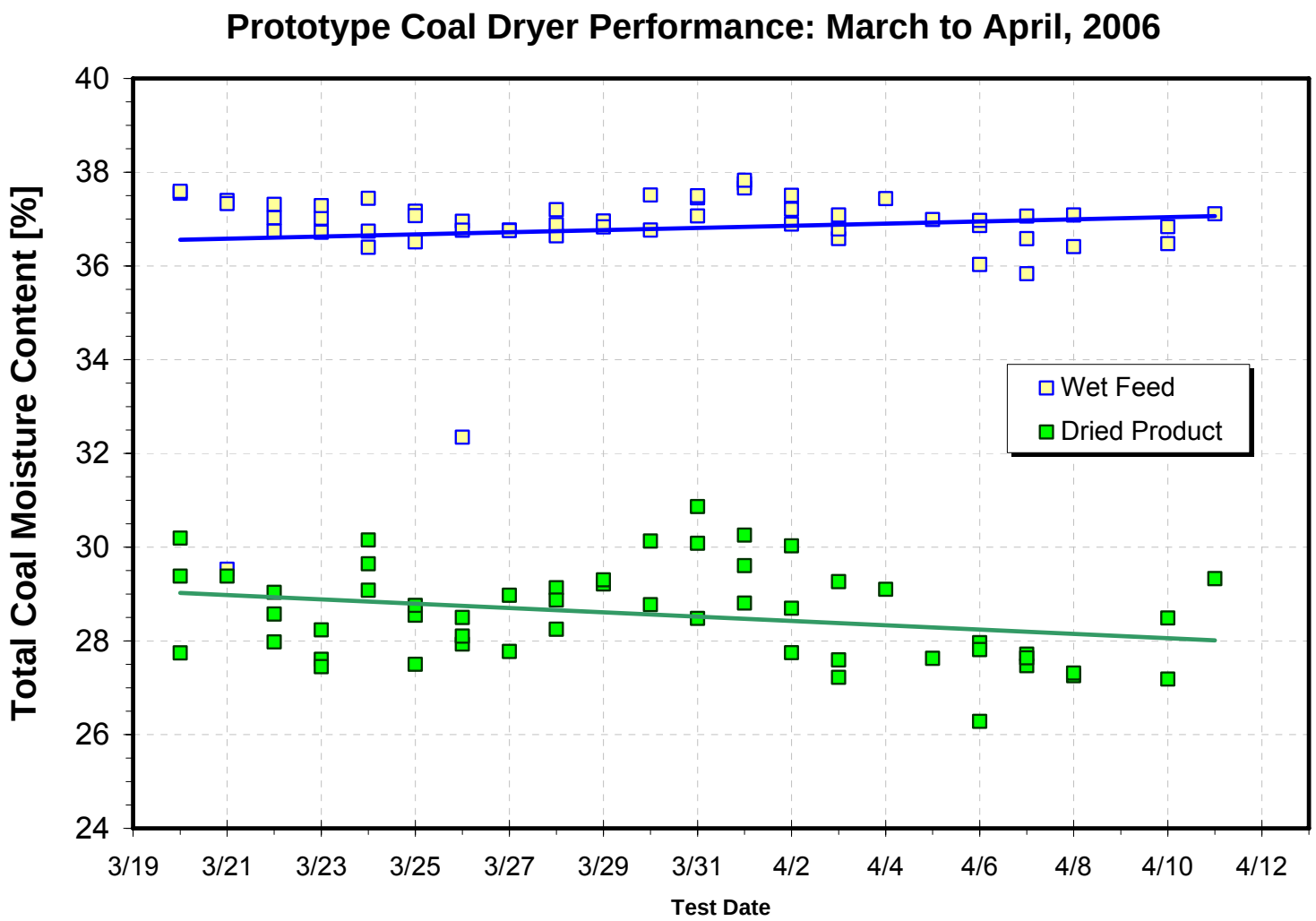
Prototype CDS Checkout, Start-Up, and Operation Summary

- Checkout and "shakedown" in December 2005.
  - No problems
- 1st coal on January 30th 2006.
- 7-hour daily tests
- Inspection on Feb11th,
  - No accumulation of material in the dryer
- Drying to 29.5%
- Segregator optimization Feb 27th to Mar 3rd 2006.
- Operator training before 24/7 operation
- Performance testing in March and April 2006.

Prototype Coal Dryer (CD26) Performance

CD26 Performance



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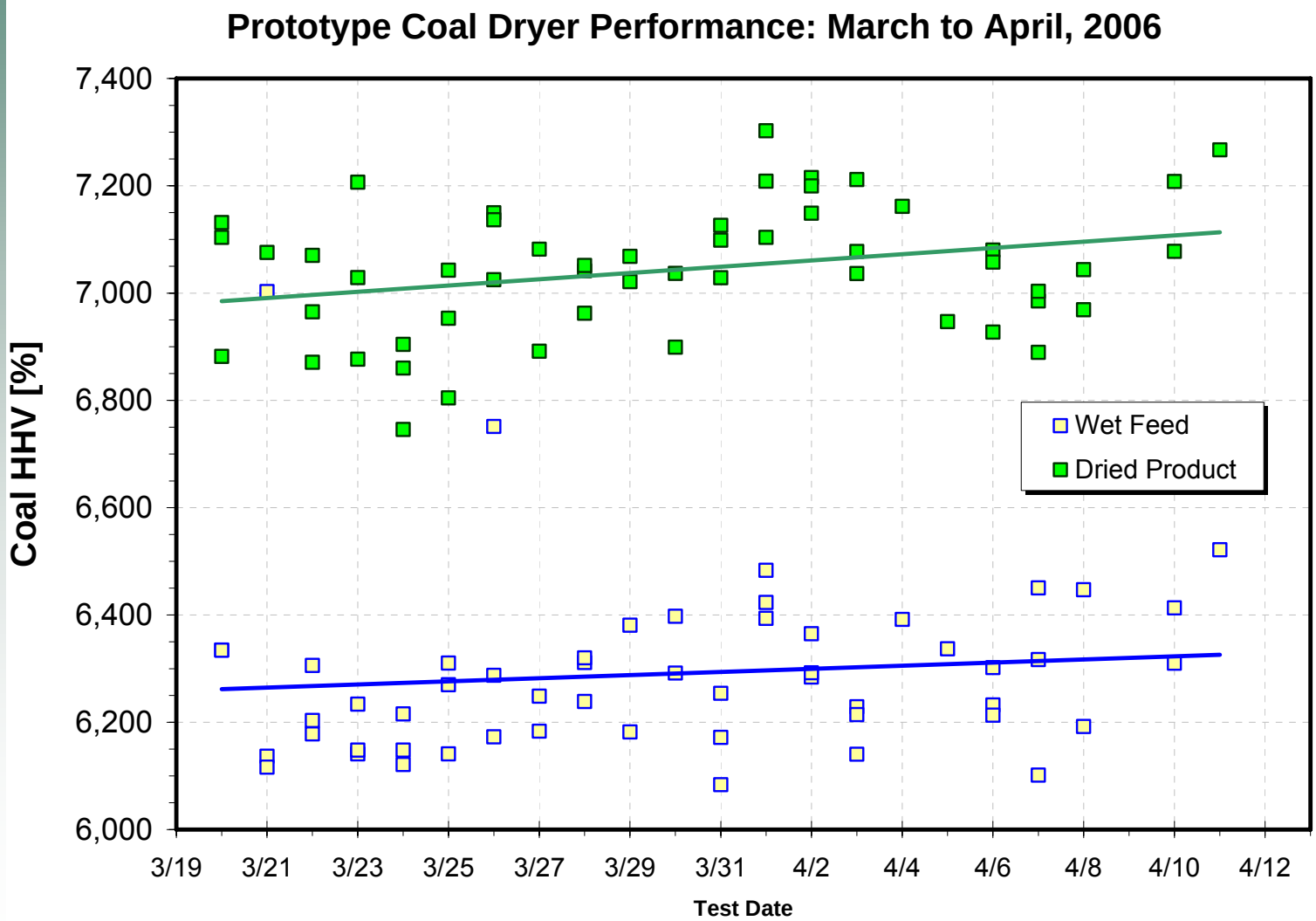
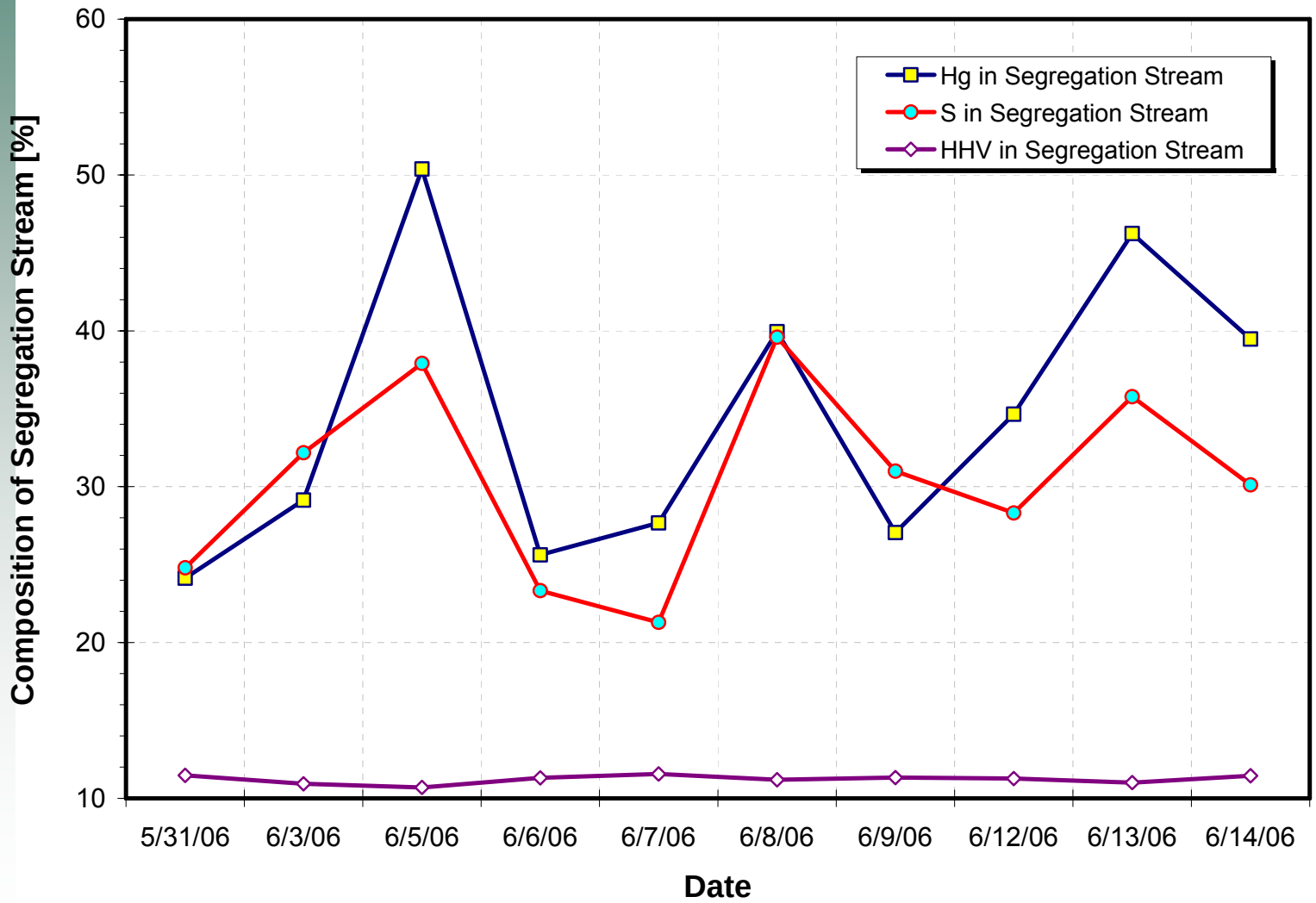
CD26 Performance



Segregation Stream



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Unit Performance

Unit Performance: Summary

Parameter	Units	Coal Dryer in Service	Coal Dryer Out of Service	Change	Units of Change
Gross Power Output	MW	589	590	**NC**	
Throttle Steam Temperature	Deg. F	988	989	**NC**	
Reheat Steam Temperature	Deg. F	1,002	1,002	**NC**	
SHT Spray Flow	klbs/hr	46	52	**-6.4**	klbs/hr
Total Coal Flow Rate	klbs/hr	953	972	**-2.02**	%
Dried Coal	% of Total	14.62	0.00		
Stack Flow Rate	kscfm	1,611	1,626	**-0.96**	%
Specific Pulverizer Work	kJ/klb	4.09	4.29	**-4.65**	%
Total Pulverizer Power	kW	4,057	4,206	**-3.53**	%
NOx Mass Emissions	lb/hr	1,345	1,470	**-8.52**	%
SOx Mass Emissions	lb/hr	3,618	3,692	**-2.00**	%
APH 21 Gas Exit Temperature	Deg. F	353	362	**-8.6**	Deg. F
APH 22 Gas Exit Temperature	Deg. F	368	377	**-9.3**	Deg. F
Stack Temperature	Deg. F	180	184	**-4.2**	Deg. F

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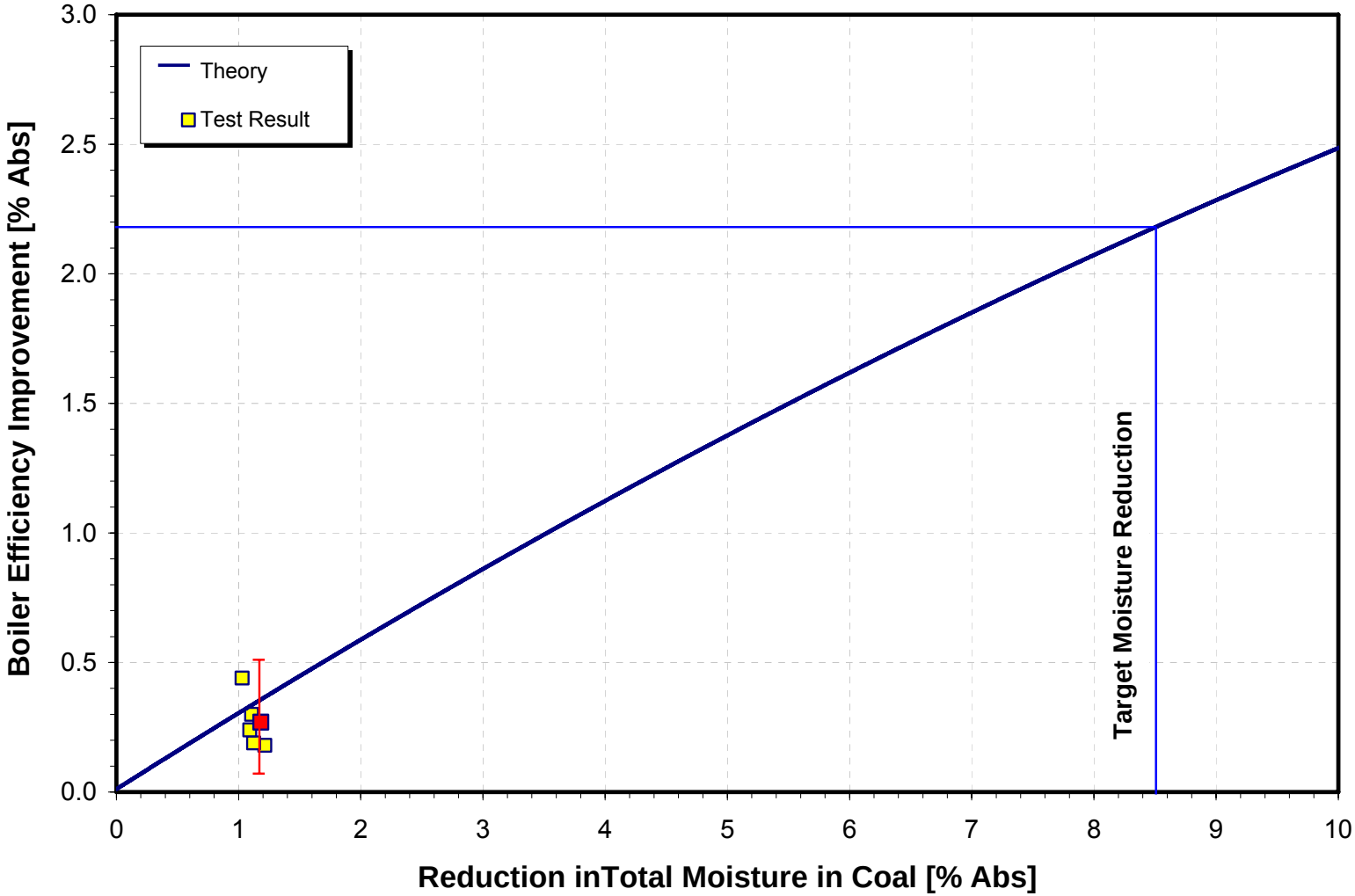
Boiler Efficiency Improvement



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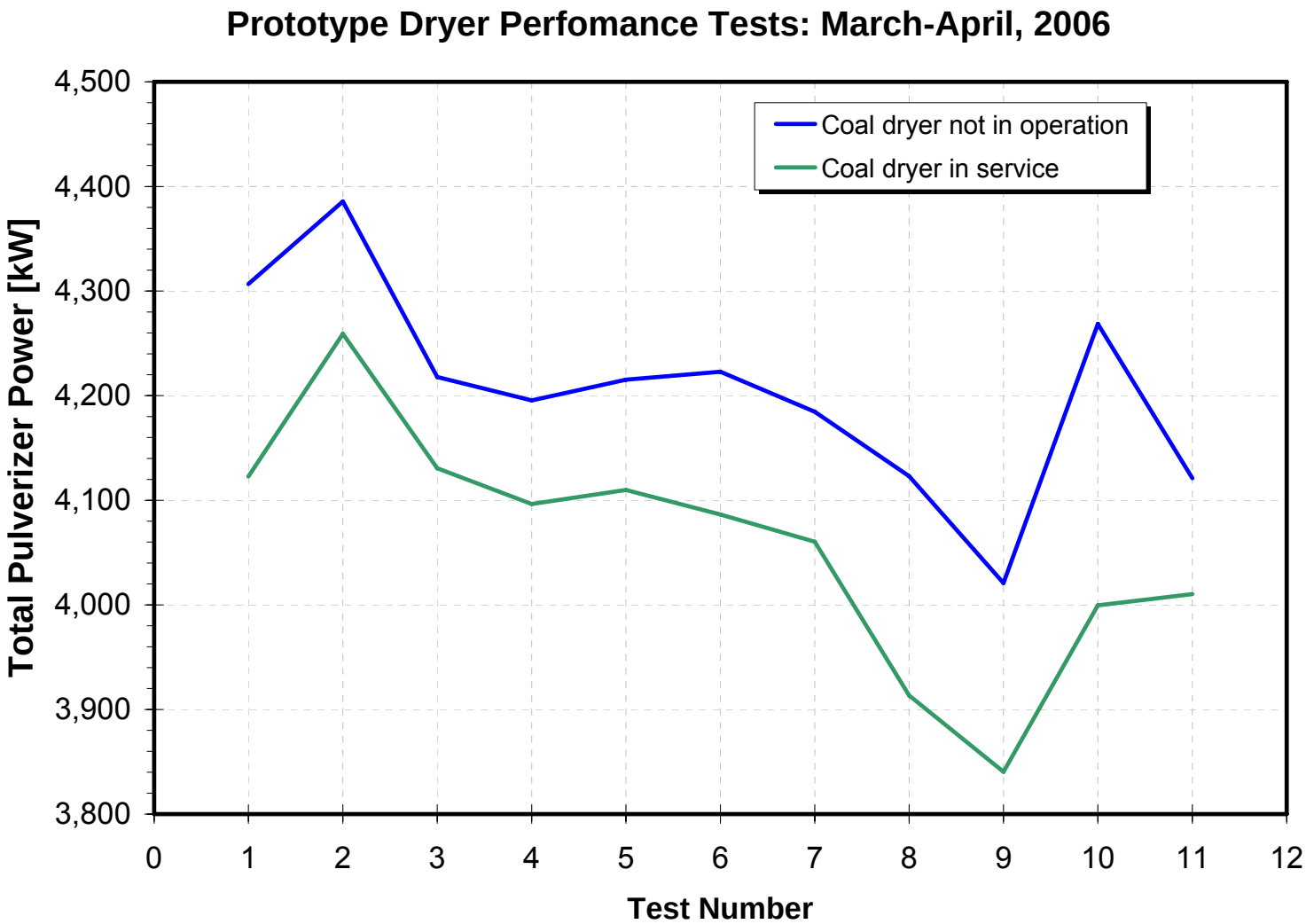
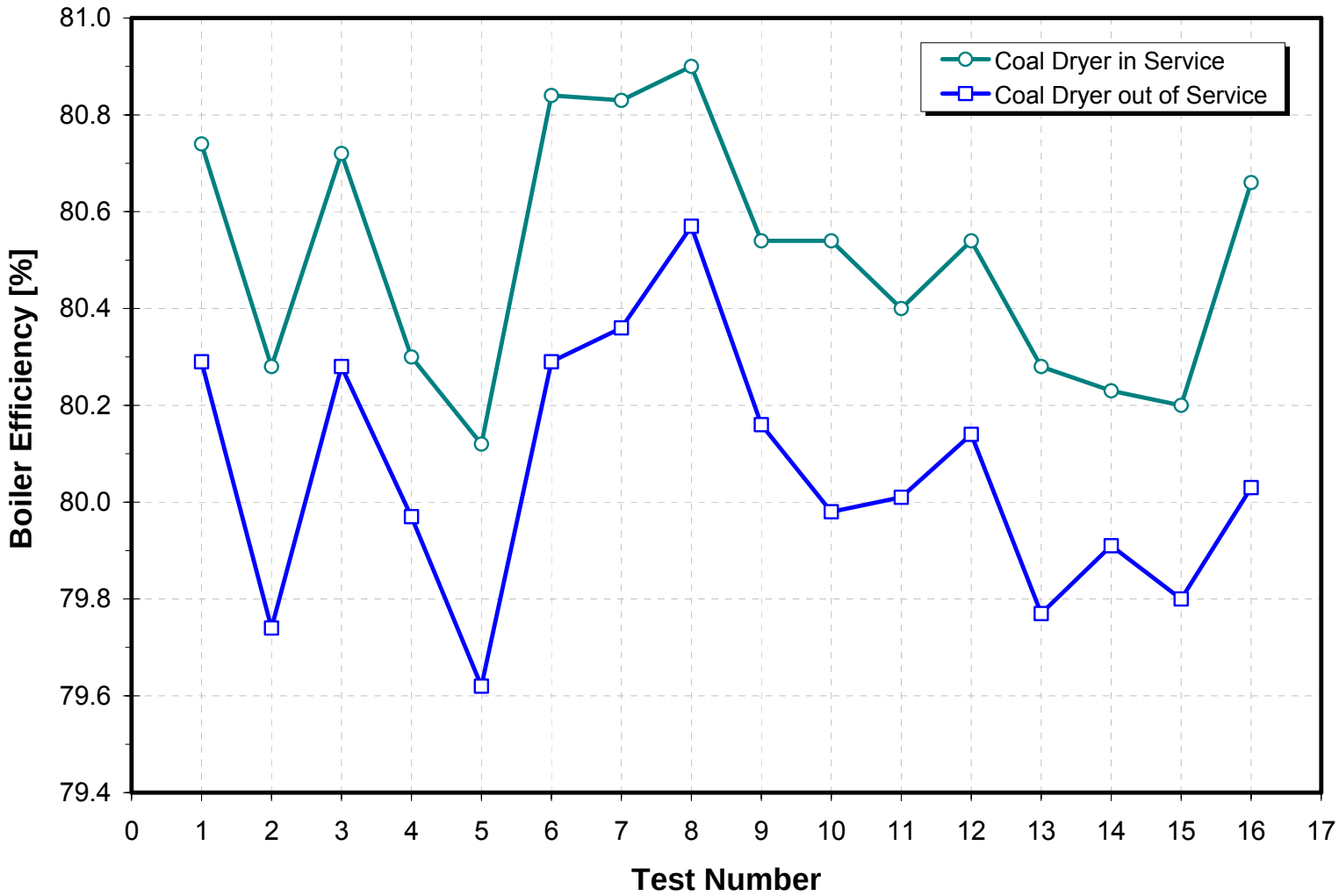
Test Data

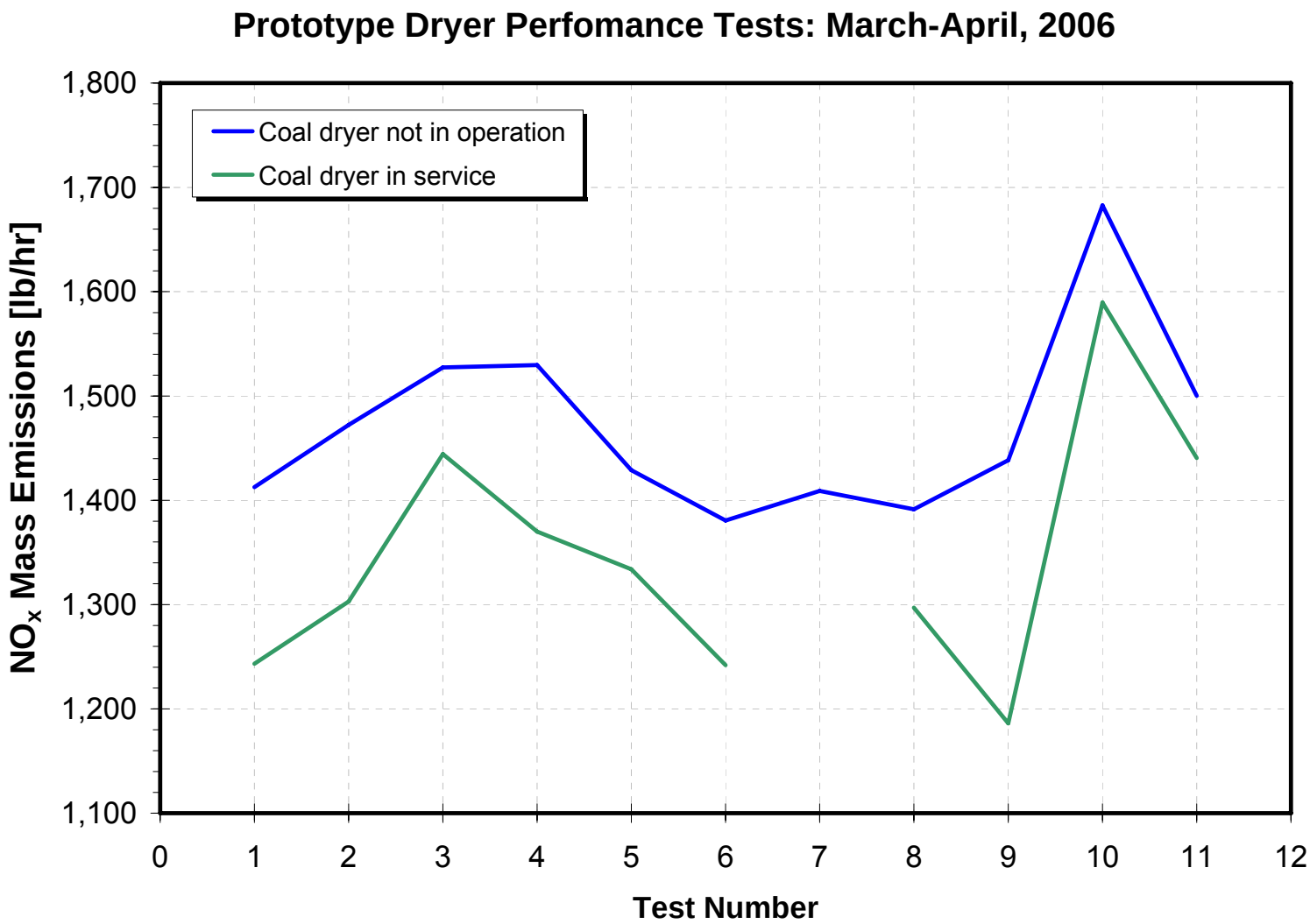
Test Data: Total Mill Power



Performance Test Results: Boiler Efficiency



Test Data: NO_x Emissions



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Evaporated Coal Moisture Discharged into the Atmosphere

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Conclusions

- *Prototype coal dryer (CD26) in service at Coal Creek since early spring 2006.*
  - *No operating issues*
  - *Nominal coal flow rate 75/t/hr.*
- *Inlet moisture level reduced by* ***8.25% Abs.***
- *Coal flow rate reduction:* ***2.0%***
- *Mill power reduction:* ***4.5%***
- *Boiler efficiency improvement:* ***0.27% Abs.***
- *Net unit heat rate improvement:* ***0.34%***
- *NO_x mass emissions reduction:* ***8.5%***
- *SO_x mass emissions reduction:* ***2.0%.***

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Conclusions

- A 75-115 ton/hr dryer was built and successfully operated at Coal Creek Station.
- The dryer performed as designed with the exception of some air flow restriction which will be corrected.
- The dry coal product produced by the dryer performed in the boiler as expected improving efficiency and reducing emissions.
- It is GRE intent to build 4 full-scale dryers and provide Coal Creek Unit 2 with 100% dry lignite. (Budget approved Feb 8th, 2007)

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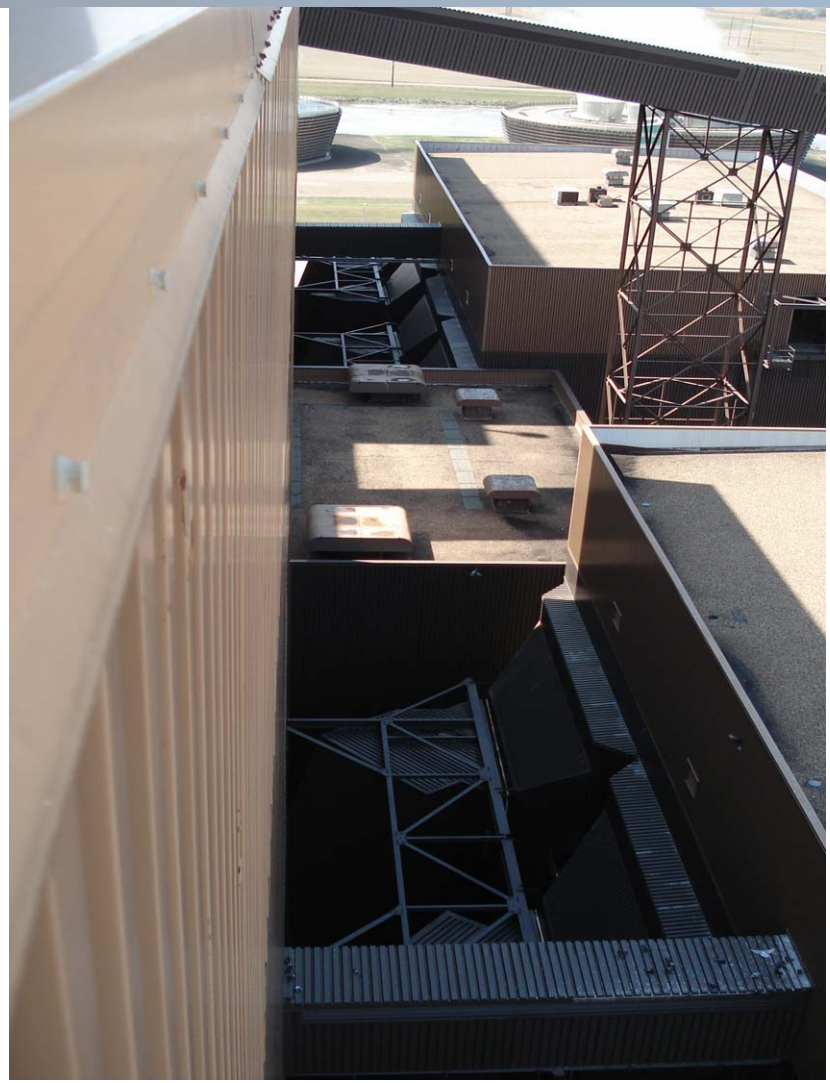
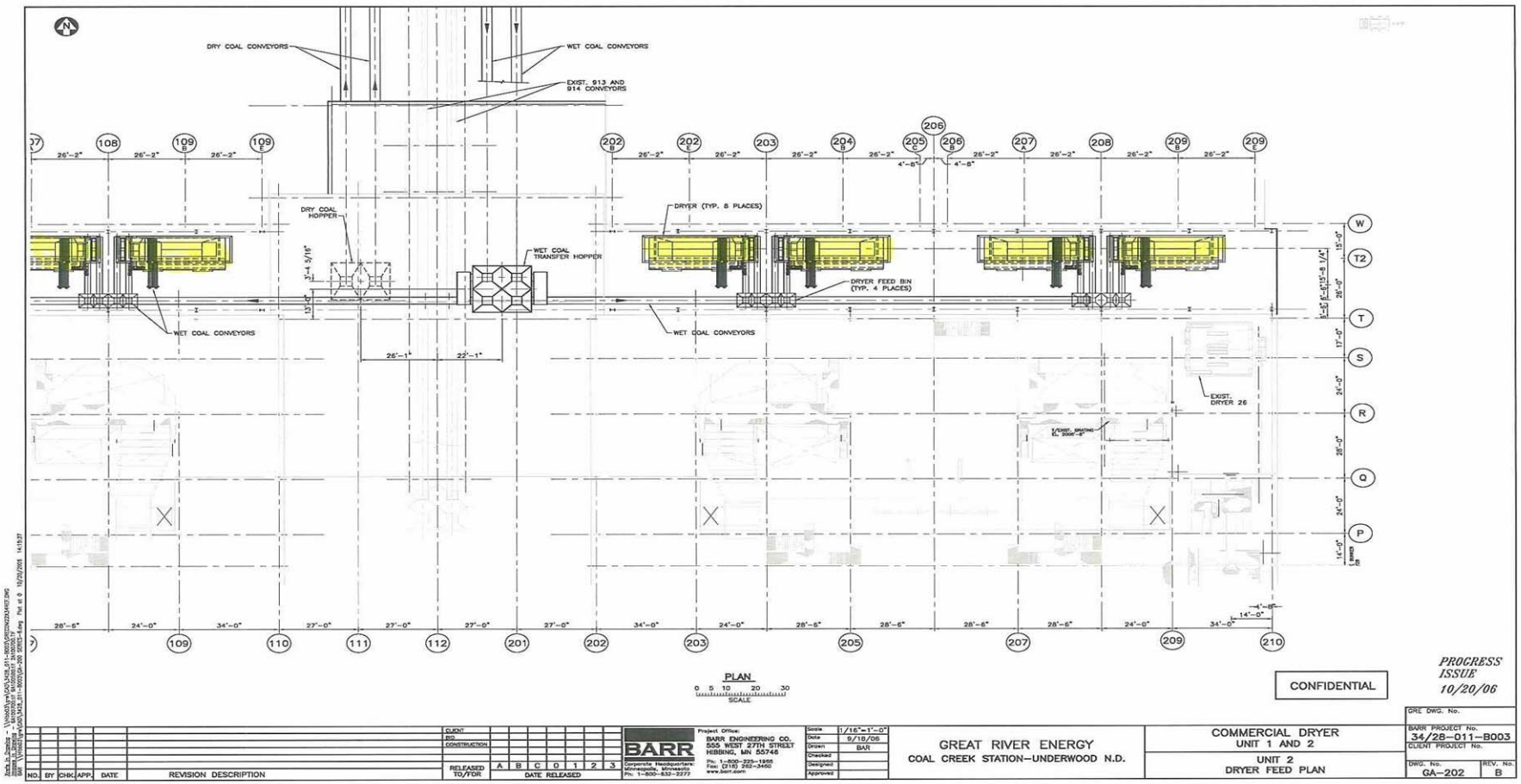
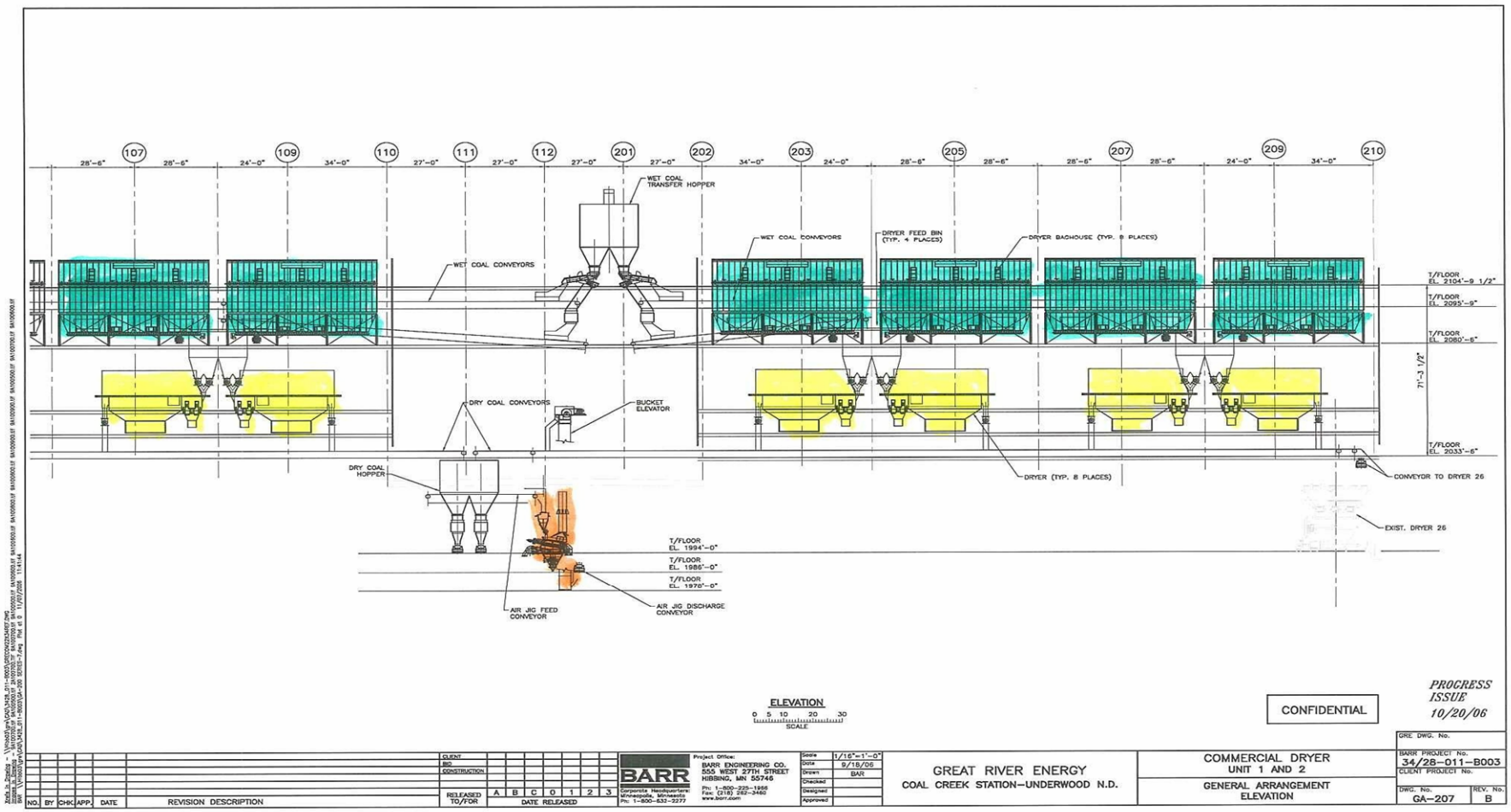
Full-Scale dryer location



Top view


DRY COAL CONVEYORS
WET COAL CONVEYORS
EXIST. 913 AND 914 CONVEYORS
DRY COAL HOPPER
WET COAL TRANSFER HOPPER
DRYER (TYP. 8 PLACES)
DRYER FEED BIN (TYP. 4 PLACES)
WET COAL CONVEYORS
WET COAL CONVEYORS
EXIST. DRYER 26
PLAN
SCALE
CONFIDENTIAL
PROGRESS ISSUE 10/20/06
GREAT RIVER ENERGY
COAL CREEK STATION–UNDERWOOD N.D.
COMMERCIAL DRYER
UNIT 1 AND 2
UNIT 2
DRYER FEED PLAN
BARR
BARR ENGINEERING CO.
555 WEST 27TH STREET
HIBBING, MN 55746
GA–202

Side elevation



Acknowledgments

- This conference paper was prepared with the support of the U.S. DOE, under Award No. DE-FC26-04NT41763.
  - However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author's and do not necessarily reflect the views of the DOE.
- The authors acknowledge and are grateful for the support received from GRE, EPRI, Barr, and Lehigh.

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